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COUNCIL APPROVES 2 FOR DEGREES

In the Scientific Council of the Institute of Automatics
and Telemechanics, Academy of Sciences USSR

At the meeting of the Scientific Council of the Institute of Automatics and Telemechanics, Academy of Sciences USSR, on 20 December 1945, a defense was conducted of a dissertation presented by M. A. Ayzerman, a co-worker of the Institute, in fulfillment of requirements for the academic degree of Doctor of Technical Sciences. The subject of the dissertation was: "The Criteria of Convergence of Processes of Automatic Regulation, Taking Into Account the Nonlinearity of the Characteristics of the Elements of the Apparatus."

The candidate examined the conditions under which the process of automatic regulation was convergent not only "for small (deviations)," but also "for large (deviations)," after the given initial deviations. Successive application of the criteria of Bendixon and the second method of Lyapunov permitted the determination of conditions, which the nonlinear differential equations describing the process of regulation must satisfy in order that the process might converge toward a position of equilibrium stabilized by the regulator after the given deviations.

It developed that for the convergence of the processes "for large (deviation)," it was sufficient to require that the nonlinear characteristics of the separate elements of the apparatus not go beyond the limits of the regions which can be set up for any system of equations by a uniform method. The fact of the convergence of the process is not dependent upon how the characteristics proceed inside these regions.

The developed methods are set forth in the dissertation for the analysis of classic types of regulators: direct action, indirect action with inflexible feedback connection, isodrome (isochronistic?) regulators, and stabilizers with additional reaction on the basis of the first derivative.

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Regions are constructed, for all types of regulators, in which the characteristics of the elements of the apparatus should proceed without disturbing the conditions of convergence of the system after the given deviations. A series of examples of a similar type was solved numerically, applicable to concrete installations of speed regulation of high-speed Diesel motors.

In conclusion the candidate formulated six new mathematical problems, the solution of which would guarantee the further perfection of methods developed in the dissertation.

The official opponents N. G. Chetayev, Corresponding Member, Academy of Sciences USSR, Professor K. F. Teodorovich, Doctor of Physicomathematical Sciences, and Professor G. G. Kalish gave the work a plus grade.

Chetayev noted, as the basic attainment of the work, the successive application of strict classical methods of Lyapunov and the ideas pointed out by Lyapunov in a demonstration of one of his theorems for the solution of concrete technical problems of automatic regulation. Chetayev emphasized, as essential attainments, that the developed method permits taking into account the nonlinearity of the characteristics fixed graphically.

Teodorovich emphasized the meaning of the work for the techniques and physics of oscillations, and noted the possibility of extending the results to certain new problems not mentioned in the dissertation.

Academician A. A. Andronov, Doctor of Technical Sciences, Professor V. K. Popov, and N. N. Nastenkov, Z. Ya. Beyrakh, M. V. Meyerov, et al, Candidates of Technical Sciences, took part in the discussion.

Andronov remarked that the dissertation of Ayzerman does not essentially contain any new mathematical conclusions, but contains conclusions necessary for the theory of regulation. Namely, in Ayzerman's dissertation, for a series of practical and important cases there is first of all given a basis of validity satisfying the procedure for linearity of the equation of motion which lies at the base of the majority of contemporary works.

Elucidating this assertion, Andronov emphasized that over 90 percent of all contemporary works on the theory of regulation are devoted to linearized problems. Among these, on the strength of Lyapunov's theorem, the criteria of Routh-Hurwitz, written for such linearized problems, permit us to speak--in relation to the original nonlinear problems--only of the convergence of the regulating process with sufficiently small deviations, which obviously does not by itself establish a procedure. The problem, linked with the basis of linear methods and the explanation of why "stability for small (deviations)" often corresponds in practice to adequate "stability for large (deviations)," was set up long ago. An essential step in the solution of this problem was made by Ayzerman.

Professor A. I. Lur'e, Doctor of Technical Sciences, also read a paper at the meeting of the Scientific Council in which he gave a brief evaluation of the work of the candidate.

By a secret vote, the Scientific Council of the Institute unanimously decided to petition for the award of a university degree of Doctor of Technical Sciences to Ayzerman.

At the same assembly of the Council, Engineer M. A. Rozenblat conducted a defense of his dissertation on the subject "Magnetic Amplifiers," presented in fulfillment of requirements for the university degree of Candidate of Technical Sciences.

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In the last few years, magnetic amplifiers have received a wide application in numerous projects of automatic operation, regulation, and control. During this time, the basic problems of theory and design of magnetic amplifiers were developed to an inadequate degree.

In the first chapter of the dissertation, the basic properties and characteristics of ferromagnetic materials under simultaneous magnetization in constant and variable magnetic fields are discussed. The obtained theoretical and experimental data is used for the analysis of various designs of magnetic amplifiers, and in the development of methods for designing certain types of amplifiers.

In the second and third chapters, the basic types of magnetic amplifiers and amplifiers with feedback are discussed. Conditions are determined for maximum output and maximum sensitivity of various types of amplifiers. The dependence of the characteristics of various magnetic amplifiers on the change of voltage and frequency of the supply source, the temperature of the surrounding area, the degree of initial magnetization, and other factors, are established. Results are drawn from experimental research on the most interesting types of magnetic amplifiers.

The fourth chapter of the work represents a specific interest. Here, evidently for the first time, the basic factors defining the temporary characteristics of magnetic amplifiers are made apparent. The theoretical analysis and experimental research, conducted by the author show that:

1. The lag in a magnetic amplifier is determined chiefly by the parameters of the control circuit.
2. In ordinary designs using magnetic amplifier with two-sided control, the dependence of the total change of the constant component of the magnetic currents in all the cores of the amplifier on the value of the signal current is close to the linear. As a consequence of this, the process of increasing the currents in the control circuits of such magnetic amplifiers can be considered as occurring according to exponential law.
3. The time constant of the cumulative magnetic amplifiers is equal to the sum of the time constants of the separate control circuits.
4. The relation of the time constants to the coefficient of amplification is a constant value for similar magnetic amplifiers, distinguished only by the parameters of the control circuits.
5. The inclusion of feedback diminishes the relation of the time constant to the coefficient of amplification.

The fifth chapter contains the author's proposed methods of designing various types of magnetic power amplifiers, and the experimental verification of the design types.

The official opponent, Professor V. V. Mil'shteyn, Doctor of Technical Sciences, remarked "The work of Comrade Rozenblat appears to be, so far as we know, the first work in which all known types of magnetic amplifiers are examined, the first work the acquaintance with which gives an adequately complete presentation of the diversity of the layouts of magnetic amplifiers, of the relative merits of the designs and construction, and creates for the reader a sufficiently wide scope for the intelligent selection of a magnetic amplifier most suitable for use in any concrete case."

Docent A. A. Feldbaum, Candidate of Technical Sciences, in his capacity as an official opponent, pointed out "The proposed methods of design appear to be completely practicable for engineering purposes. Therefore, they, together with the rich experimental data collected in the present work, deserve wide distribution among engineers having to do with design construction and research of magnetic amplifiers."

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Noting the significant merits and practical value of the dissertation "Magnetic Amplifiers," the official opponents expressed the desire to direct further work in the field of theory and design of magnetic amplifiers.

By a secret vote, the Scientific Council unanimously decided to award Rozenblat the university degree of Candidate of Technical Sciences.

The basic ideas of the developed methods are set forth in articles by the candidates in the periodical, "News of the Academy of Sciences, Department of Technical Sciences" 12 (1944), and in the periodical "Automation and Telemechanics" 2 - 3 (1946), 1 (1947).

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